77TH CONGRESS } HOUSE OF REPRESENTATIVES { DOCUMENT
1st Session } { No. 290

NORFORK DAM, NORTH FORK RIVER, ARK.

LETTER

FROM

THE SECRETARY OF WAR

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, UNITED STATES ARMY, DATED MAY 1, 1941, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON RE-EXAMINATION OF NORFORK DAM, NORTH FORK RIVER IN WHITE RIVER BASIN, ARK. AND MO., REQUESTED BY RESOLUTION OF THE COMMITTEE ON FLOOD CONTROL, HOUSE OF REPRESENTATIVES, ADOPTED JUNE 20, 1940.

JUNE 25, 1941.—Referred to the Committee on Flood Control and ordered to be printed with two illustrations

WAR DEPARTMENT,
Washington, June 20, 1941.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES:

DEAR MR. SPEAKER: I am transmitting herewith a report dated May 1, 1941, from the Chief of Engineers, United States Army, together with accompanying papers and illustrations, on review of the "Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers" as contained in Committee Document No. 1, Seventy-fifth Congress, first session, with a view to determining whether provisions should be made for the generation of hydroelectric power, at this time, in the Norfork Dam on the North Fork River in the White River Basin, Ark. and Mo., which is authorized for flood control by the Flood Control Act approved June 28, 1938. This investigation was requested by resolution of the Committee on Flood Control, House of Representatives, adopted June 20, 1940.

The Bureau of the Budget has been consulted and advises that authorization of the modified project recommended by the Chief of Engineers would not be in conflict with the program of the President,

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but that no commitment is made thereby with respect to the rate at which funds should be expended for the construction of the project.

Sincerely yours,

HENRY L. STIMSON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, May 1, 1941.

The CHAIRMAN, COMMITTEE ON FLOOD CONTROL,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: 1. The Committee on Flood Control of the House of Representatives, by resolution adopted June 20, 1940, requested the Board of Engineers for Rivers and Harbors to review the report on the "Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers," as contained in Committee Document No. 1, Seventy-fifth Congress, first session, with a view to determining whether provisions should be made for the generation of hydroelectric power, at this time, in the Norfork Dam on the North Fork River in the White River Basin, Ark. and Mo., which is authorized for flood control by the Flood Control Act approved June 28, 1938. I enclose the report of the Board in response thereto.

2. After full consideration of the report secured from the district engineer, the Board reports that provision should be made at this time for the generation of hydroelectric power at the Norfork Dam on the North Fork River in the White River Basin, Ark. and Mo., and for transmission and sale of the power, generally in accordance with the plans outlined in the district engineer's report, and with further minor modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, at an estimated first cost of $13,500,000, and $70,000 annually for maintenance and operation.

3. After due consideration of these reports, I concur in the views and recommendations of the Board.

Very truly yours,

J. L. SCHLEY,
Major General, Chief of Engineers.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

WAR DEPARTMENT,
THE BOARD OF ENGINEERS
FOR RIVERS AND HARBORS,
Washington, March 3, 1941.

Subject: Norfork Dam on the North Fork River in White River Basin, Ark. and Mo.

To: The Chief of Engineers, United States Army.

1. This report is in response to the following resolution, adopted June 20, 1940:

Resolved by the Committee on Flood Control, House of Representatives, That the Board of Engineers for Rivers and Harbors, created under section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby, requested to review the report on the "Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers" as contained in Committee Document No. 1, Seventy-fifth Congress,

first session, with a view to determining whether provisions should be made for the generation of hydroelectric power, at this time, in the Norfork Dam on the North Fork River in the White River Basin, Arkansas and Missouri, which is authorized for flood control by the Flood Control Act approved June 28, 1938.

2. The Norfork Reservoir, on the North Fork River in Baxter County, Ark., is one of a group of 6 authorized for flood control in the White River Basin and other purposes by the Flood Control Act of June 28, 1938, in accordance with the general comprehensive plan contained in Committee Document No. 1, Seventy-fifth Congress, first session. Provision is made in the act for modifications of the plan as in the discretion of the Secretary of War and the Chief of Engineers may be advisable; also for the installation of penstocks in the dams for future development of hydroelectric power. For the initiation and partial accomplishment of the plan, the act authorized $25,000,000 for reservoirs. Clearwater and Norfork Reservoirs have been selected for construction with this sum and work on both of them has been started.

3. North Fork River is approximately 115 miles long and drains an area of 1,780 square miles lying in the Ozark Mountains in Missouri and Arkansas. It joins the White River near Norfork, Ark. 378 miles above the mouth. The White River rises in the Boston "Mountains" in northwestern Arkansas and flows generally southeasterly 720 miles to join the Mississippi River 45 miles upstream from Arkansas City. Its watershed, extending from the Ozark Plateau to the Mississippi lowlands, has a total area of 28,000 square miles and a population of 750,000. Farming is the principal occupation. Vegetables, fruits, cotton, corn, hay, and livestock are raised. The most important natural resources are forest products, coal, manganese ore, glass sand, natural gas, clay, tripoli, lead and zinc ores. Existing improvements for navigation provide for channel maintenance between the mouth and Batesville, mile 301, and for canalization by 3 locks and dams between Batesville and Guion, mile 331.

4. Floods are of frequent occurrence in the White River Basin and cause considerable damage in the fertile lowlands along the lower reaches of the stream. Improvements authorized by Congress for flood control include five levee projects in the main valley and the six reservoirs on the tributaries which would have a flood storage capacity of 2,935,000 acre-feet. The Norfork Reservoir as now being constructed has a capacity of 1,251,000 acre-feet below the crest of the dam spillway. The dam height is 228 feet, and four penstocks will be provided for future development of hydroelectric power.

5. Local interests desire that the Norfork Dam be constructed for the combined purpose of flood control and the development of hydroelectric power and that provision for power generation be made at this time. The urgent need for additional power capacity, the demand for cheap electric energy for industrial, commercial, and domestic purposes, and the desire for recreational facilities are the principal reasons advanced for the justification of power facilities.

6. The district engineer finds that the most suitable improvement is a dual-purpose reservoir of 1,983,000 acre-feet capacity, of which 732,000 acre-feet would be utilized for flood control and 707,000 acre-feet for power regulation, with an initial power installation of 60,000 kilowatts, and penstocks for 60,000 kilowatts additional. The cost is estimated as $27,500,000 for construction and $90,000 annually for maintenance and operation. The increase in cost over the cost of the

reservoir for flood control alone is estimated as $13,500,000 and after considering added maintenance and operation costs the annual charges for the added power development are estimated as $658,000. The total prospective power is estimated as 148,000,000 kilowatt-hours per year. Of this amount 108,000,000 would be primary and 40,000,000 secondary. Marketable power is estimated as 138,000,000 kilowatt-hours per year with a capacity of 53,000 kilowatts. The Federal Power Commission values this power at $894,000, or approximately 6.5 mills per kilowatt-hour at or near available load centers; and has made an extensive power survey to prove the existence of a market. In view of an estimated value (thus determined) somewhat higher than the cost of production and of the results of the Federal Power Commission power survey above cited, which shows that the output of the plant could be absorbed in the adjacent area, the district engineer, who is also acting division engineer, recommends that the project be modified to provide for construction of the Norfork Dam and Reservoir for the combined purpose of flood control and power development at a total estimated cost of $27,500,000 for new work and $90,000 annually for maintenance and operation.

VIEWS AND RECOMMENDATIONS OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

7. The Board concurs with the reporting officer. The Norfork Reservoir site is adapted to the construction of a multiple-purpose project for flood control, power development, and other uses. Investigation indicates that the power can be produced at a reasonable cost and that there is a market available for disposal of the output. In the opinion of the Board the construction of the multiple-purpose project is fully justified at this time and it is desirable that it be undertaken immediately and generally in accordance with the plan proposed by the district engineer because of the savings which will be made by installation of the power facilities now instead of at some later date. In order to insure the best service to the area it is advisable that provision be made to construct, operate, and maintain transmission lines, substations and facilities, and structures appurtenant thereto, as may be found necessary for transmission, interchange and sale of the energy. To safeguard the interests of navigation and flood control the dam and power facilities should be constructed, operated and maintained under the direction of the Secretary of War and the supervision of the Chief of Engineers; the power to be disposed of under contracts approved by the Federal Power Commission.

8. The Board accordingly reports that provision should be made at this time for the generation of hydroelectric power at the Norfork Dam on the North Fork River in the White River Basin, Ark. and Mo., and for transmission and sale of the power, generally in accordance with the plans outlined in the district engineer's report and the comments herein, and with further minor modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, at an estimated first cost of $13,500,000, and $70,000 annually for maintenance and operation.

For the Board:

THOMAS M. ROBINS,
Brigadier General, Corps of Engineers,
Senior Member.

SURVEY OF NORFORK DAM, NORTH FORK RIVER, ARK.

SYLLABUS

The district engineer finds that the topography and foundation conditions at the Norfork Dam site on the North Fork River in the White River Basin, Ark. and Mo., are suitable for the construction of a high dam for both flood control and the production of hydroelectric power. He further finds, based upon the Federal Power Commission's estimates of the power market growth and unit power values, that it is economically feasible to develop the site for power production in conjunction with flood control and that provisions should be made for the generation of hydroelectric power at this time. Therefore, the district engineer recommends that the general comprehensive plan for flood control and other purposes in the White River Basin as approved in the Flood Control Act of June 28, 1938, be modified to approve the construction of the Norfork project for the combined purpose of flood control and the development and distribution of hydroelectric power and that the existing authorization of $25,000,000 for the initiation and partial accomplishment of the basin reservoir plan be increased by $13,500,000 to provide for the immediate construction of the dual-purpose project at the Norfork site. He also recommends that the dam and power facilities be constructed, operated, and maintained under the direction of the Secretary of War and the supervision of the Chief of Engineers, the power to be disposed of under contracts approved by the Federal Power Commission.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 10, 1940.

Subject: Survey Report for Hydroelectric Power, Norfork Dam on the North Fork River in the White River Basin, Ark. and Mo.

To: The Chief of Engineers, United States Army.
(Through the Division Engineer, Southwestern Division.)

1. *Authority.*—This survey report is made in compliance with the provisions of a resolution adopted June 20, 1940, by the Committee on Flood Control of the House of Representatives, which reads as follows:

Resolved by the Committee on Flood Control, House of Representatives, That the Board of Engineers for Rivers and Harbors, created under section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report on the "Comprehensive flood-control plan for Ohio and lower Mississippi Rivers" as contained in Committee Document No. 1, Seventy-fifth Congress, first session, with a view to determining whether provisions should be made for the generation of hydroelectric power, at this time, in the Norfork Dam on the North Fork River in the White River Basin, Arkansas and Missouri, which is authorized for flood control by the Flood Control Act approved June 28, 1938.

2. *Report under review.*—The report under review was prepared immediately after the great flood of January 1937 in the Ohio River, and the Chief of Engineers recommended a system of flood-control reservoirs and other works for further flood control in the Ohio and lower Mississippi Rivers. The report was published in 1937 for the official use of the Committee on Flood Control and is contained in Committee Document No. 1, Seventy-fifth Congress, first session. Included in the plan for further flood control were six flood-control reservoirs in the White River Basin, among which was the Norfork Reservoir near the mouth of the North Fork River (White River, mile 378). The Flood Control Act of June 28, 1938, approved the general comprehensive reservoir plan in the White River Basin, as set forth in that document, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable.

3. *Historical data.*—The Dixie Power Co. was the first organization to be issued a permit covering power investigations along the reach

of the North Fork River in the vicinity of the Norfork Dam site. The Federal Power Commission issued to that company preliminary permits covering the upper White River (project No. 1) and North Fork River (project No. 214). Subsequently, permits covering reaches in the upper White River, North Fork River, and Buffalo River (White River, mile 389) were granted to the Dixie Power Co. by the Arkansas Railroad Commission.

4. In 1925 the Federal permits issued to the Dixie Power Co. were allowed to expire. This situation afforded other interested organizations an opportunity to file applications relative to the project areas involved in the expired permits. The White River Power Co. and the Ozark Hydroelectric Power Co. responded to this opportunity by submitting conflicting applications. The Arkansas Railroad Commission then granted, under protest from the Dixie Power Co. and the White River Power Co., a permit to the Ozark Hydroelectric Power Co. authorizing this concern to develop the upper White River, North Fork River, and Buffalo River. The State permit previously granted the Dixie Power Co. was revoked.

5. After much consideration, during the period 1925 to 1928, the Federal Power Commission issued a preliminary permit (project No. 654) to the White River Power Co. This permit covered the upper White River, North Fork River, and Buffalo River. The application of the Ozark Hydroelectric Power Co. was denied. This action taken by the Federal agency resulted in the submission of a petition, by the Ozark Hydroelectric Power Co. to the Arkansas Railroad Commission requesting authority to transfer to the White River Power Co. the rights previously granted the petitioner by that State commission. The petition was successful, and the authority thereby granted enabled the White River Power Co. to become the sole possessor of Federal and State rights which authorized investigations and development of certain reaches of the upper White River, North Fork River, and Buffalo River with a view to producing hydroelectric power.

6. In 1930, approximately 2 years after the issue of the preliminary permit, the White River Power Co. made application to the Federal Power Commission for license to construct dams at the following locations: At Wild Cat Shoals (White River, mile 408) on White River; near Rush Creek on Buffalo River; and near the mouth on North Fork River. Upon receipt of the application for license, the Federal Power Commission informed the White River Power Co. that serious consideration was being given to the rejection of the proposed developments on the Buffalo and North Fork Rivers on the grounds that sufficient progress had not been made on these projects and that it was the opinion that the date of beginning construction on them was very problematical. It was the intention of the applicant to initiate the developments by beginning construction of a high-head dam at Wild Cat Shoals. In view of this priority, both surface and subsurface investigations were concentrated at this locality. Foundation conditions disclosed by these investigations were regarded as unsatisfactory for a high-head dam and, accordingly, the Federal Power Commission directed that the project plans be suitably modified.

7. On April 16, 1934, the White River Power Co. submitted an amended application for license for project No. 654. This amended

application eliminated the dams on the Buffalo and North Fork Rivers and substituted for the high-head dam on White River a series of three low-head dams on that stream at Wild Cat Shoals and at two sites upstream therefrom.

8. In 1936, the Federal Power Commission authorized, subject to certain provisions and conditions, the issue of a license to construct the Wild Cat Shoals Dam to the modified height set forth in the amended application; but, on June 29, 1938, the Commission ruled that the order of December 8, 1936, authorizing the issue of the license, be rescinded and consideration of the application for license be suspended pending the determination of the projects in the White River Basin which will be undertaken by the United States. Therefore, at the present, there are no existing or pending authorizations for the development of hydroelectric power by private concerns in the North Fork River or in the adjacent streams in the upper White River Basin.

9. *Prior reports.*—The pertinent published reports of the War Department are shown in table No. 1. All of these reports include consideration of the Norfork Reservoir, along with other reservoirs, for flood control, and the report published as House Document No. 102, Seventy-third Congress, first session, also gives consideration to the hydroelectric potentialities of the Norfork Reservoir.

TABLE No. 1.—*Prior reports*

Date	Document				Name of report	Nature of report and recommendations
	House or Committee	Number	Congress	Session		
1931	House	798	71	3	Control of floods in the alluvial valley of the lower Mississippi River.	Review of the projects adopted by Congress May 15, 1928, for flood control and navigation of the Mississippi River and its alluvial valley. Unfavorable for a system of reservoirs.
1932	House	102	73	1	White River, Mo. and Ark.	Survey report containing a general plan for the improvement of White River, Mo. and Ark., for the purposes of navigation and efficient development of its water power, the control of floods, and the needs of irrigation. Unfavorable for participation by the United States in the comprehensive improvement of White River for navigation in combination with the development of potential water power, flood control, and irrigation.
1935	House	259	74	1	Comprehensive report on reservoirs in Mississippi River Basin.	Survey report on further flood control of the lower Mississippi River by control of floodwaters in the drainage basins of the tributaries by the establishment of a reservoir system. Favorable for receiving from local interests plans and proposals for reservoir construction and for reporting to Congress the Federal expenditures that would be justified for such proposals by reason of general benefits, and the local contributions that should be required because of local benefits.
1937	Committee	1	75	1	Comprehensive flood-control plan for Ohio and lower Mississippi Rivers.	Review of reports and data obtained from the 1937 flood with a view to submission of revised comprehensive plans for protective works against floods in the Ohio and Mississippi Valleys. Favorable for a system of flood-control reservoirs.

TABLE No. 1.—*Prior reports*—Continued

Date	Document				Name of report	Nature of report and recommendations
	House or Committee	Number	Congress	Session		
1940	House	917	76	3	White River, Ark. and Mo.	Review of reports on surveys at Table Rock (White River, mile 528) and Wild Cat Shoals Reservoirs, and also a review of the report contained in Committee Doc. No. 1, 75th Cong., 1st sess., with a view to determining whether a dam at Wild Cat Shoals may be economically justified for flood control and power development in lieu of the Lone Rock, on Buffalo River near the mouth, and Norfork Dams recommended in that document. Favorable for constructing the Table Rock and Bull Shoals (White River, mile 420, alternate for Wild Cat Shoals) Reservoirs for flood control and power development. The report concluded that the Table Rock, Bull Shoals, Lone Rock, and Norfork Reservoirs should all be included in a comprehensive plan for the development of the water resources of the White River Basin.

10. *Existing projects.*—There are no hydroelectric projects authorized by the United States Congress in the White River Basin, which includes the North Fork River, or in other nearby basins. The Flood Control Act of June 28, 1938, approved the general comprehensive plan for flood control and other purposes in the White River Basin, as set forth in Flood Control Committee Document No. 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War and the Chief of Engineers may be advisable, and authorized the sum of $25,000,000 for reservoirs, for the initiation and partial accomplishment of the plan, the reservoirs to be selected and approved by the Chief of Engineers. The reservoirs included in the comprehensive plan are listed in table No. 2.

TABLE No. 2.—*Reservoirs included in the comprehensive White River basin plan as approved by the Flood Control Act of 1938*

Reservoir	Location
Clearwater	On Black River near Clearwater, Mo.
Water Valley	On Eleven Point River near Water Valley, Ark.
Bell Foley	On Strawberry River near Bell Foley, Ark.
Norfork	On North Fork River near Norfork, Ark.
Lone Rock	On Buffalo River near Lone Rock, Ark.
Greers Ferry	On Little Red River near Greers Ferry, Ark.

11. Under the provisions of the project authorization, the Chief of Engineers has selected the Clearwater and Norfork Reservoirs to be constructed with the limited sum of money authorized for the initiation and partial accomplishment of the reservoir plan. The Clearwater Reservoir is now under construction. The main dam at the Norfork site has not yet been placed under contract; however, the Government village and the access road and railroad to the site are under construction. The estimated cost of the Norfork project for flood control alone is $14,000,000; however, owing to the suitability of the site for the dual purpose of flood control and power generation, plans have been approved under the existing authority to include

pen stocks and other similar facilities in order to permit future power generation in conjunction with flood control. These power facilities will increase the cost of the structure.

12. The total cost of new work for the approved reservoirs in the White River Basin to June 30, 1940, was $1,085,400, of which $297,100 was for the Norfork Reservoir. Since none of the reservoir projects have been completed, there have been no expenditures for annual operation and maintenance, nor is there an approved estimated cost therefor.

13. Although there are no navigation projects in the North Fork River Basin, there are projects along the White River into which the North Fork River empties at mile 378. There are three locks and dams on White River between Guion, Ark. (mile 331), and Batesville, Ark. (mile 301), which provide 4-foot slack-water navigation. Branson, Mo. (mile 520), is considered the head of navigation on White River; however, upstream from Guion, navigation is largely limited to recreational boating. The open-river navigation project in the lower White River provides for channel maintenance between the mouth of the river and Batesville by snagging and dredging and by contraction works. No part of the North Fork River is considered navigable.

14. *Improvements by other Federal and non-Federal agencies.*—There are no stream improvement works constructed by other Federal agencies in the vicinity of the proposed Norfork Reservoir. About 1904 or 1905, a rock-fill dam with the upstream side faced with boards was constructed in the channel of the North Fork River at mile 51.2 as a private enterprise. The top elevation is 572 feet above mean sea level and the structure has a crest length of 425 feet. The dam, about 10 feet in maximum height, has a crown width of 2 feet and the base is about 9 feet wide. The structure is apparently in fair condition although the pool has silted up to within about 2 feet of the top of the dam. Water is carried from the dam to two 40-horsepower turbines by an open stone masonry millrace which is 4 feet deep, 11 feet wide, and 200 feet long. The turbines normally operate on an 8-foot head, but during flood periods the dam is submerged. The turbines furnish power for the operation of a flour mill, corn mill, one stand cotton gin, one 32-volt generator, and one air compressor. All machinery seems to be in fair condition and is in operation most of the time. The dam is within the upstream limit of the flood-control pool which would be formed by the dual-purpose flood-control and power dam at the Norfork site.

15. *Description.*—The Norfork Dam site is on the North Fork River 4.8 river miles upstream from its confluence with the White River. The site is in Baxter County in north central Arkansas and is about 4 miles northeast of Norfork, Ark. It lies in sections 2 and 11, township 18 north, range 12 west. The drainage area above the site is 1,765 square miles, which constitutes about 99 percent of the entire drainage basin of the North Fork River.

16. The North Fork River watershed, which contains about 6.4 percent of the entire White River drainage area, lies in the Ozark highland in south central Missouri and north central Arkansas. It is roughly a rectangular-shaped area about 63 miles in length in a north-south direction by approximately 28 miles in average width and comprises an area of 1,780 square miles, of which 1,360 square miles are in Missouri and 420 square miles are in Arkansas. In

Missouri, parts of Texas, Wright, Howell, Douglas, and Ozark Counties are in the basin, and, in Arkansas, parts of Baxter, Fulton, and Izard Counties are in the drainage area. The area is mountainous to rolling and is generally wooded except in the narrow stream flood plains which are largely under cultivation. The elevation at the source of the river is about 1,150 feet above mean sea level and the elevation of the valley land near the mouth of the stream is about 390 feet.

17. The North Fork River is approximately 115 miles in length. Its source is in the southwestern part of Texas County, Mo. The stream flows in a general southerly direction through eastern Douglas and Ozark Counties, Mo., to cross the Arkansas-Missouri State line near river mile 39. After entering Arkansas, the stream continues in a southerly direction through the eastern part of Baxter County to join the White River at mile 378 near Norfork, Ark. The North Fork River is classed as a clear-water stream. The average fall for the entire length of the stream is about 7 feet per mile, but the slope is very steep in the upper reaches. From river mile 52 (approximate head of dual-purpose flood-control and power reservoir) to the mouth, the average fall is a little more than 4 feet per mile. Profiles of the North Fork and White Rivers are attached hereto.

18. The channel of the stream below the Norfork dam site averages about 400 feet in width and occupies a bed of gravel, boulders, and rock. It is confined, generally, between rugged stable banks which are formed in earth and rock bluffs. The channel capacity in the vicinity of the dam site is variable owing to backwater effects of the White River. With no backwater effect, the capacity is about 60,000 cubic feet per second. The channel capacity of the White River immediately downstream from the mouth of the North Fork River is about 100,000 cubic feet per second but it is reduced to about 78,000 cubic feet per second in the lowlands near Batesville (White River, mile 301) and Newport, Ark. (White River, mile 258).

19. The North Fork River has many tributaries, but most of them have small drainage areas. Pertinent data relative to the principal tributaries, and points of interest along the main stem, are indicated in table No. 3.

TABLE No. 3.—*Principal tributaries and points of interest*

Name of tributary or locality	Distance above mouth of main stem	Length of tributary	Drainage area of tributary	Percent of total drainage area in basin (1,780 square miles)	Total drainage area above mouth of tributary or locality
	Miles	*Miles*	*Square miles*		*Square miles*
Noblett Creek	73.9	19	153	8.6	374
Spring Creek	57.4	24	114	6.4	549
Bryant Creek	49.0	68	580	32.6	1,148
Tecumseh, Mo. (gage)	48.4				1,150
Lick Creek	44.6	19	84	4.7	1,272
Arkansas-Missouri State line	39.3				1,285
Pigeon Creek	27.8	13	70	3.9	1,401
Bennetts River	20.4	28	180	10.1	1,589
Henderson, Ark. (gage)	20.0				1,590
Big Creek	5.9	34	118	6.6	1,763
Norfork Dam site	4.8				1,765
Norfork Dam site No. 3 gage	4.2				1,766
Missouri Pacific R. R. (Norfork gage)	.2				1,780
Norfork, Ark. (mouth)	0				1,780

20. The North Fork River Basin lies in a region characterized by a humid climate with precipitation well distributed throughout the year. The precipitation, which averages about 45 inches per year, is usually adequate for crop production. The crop-growing seasons are long, and the winters are generally short and mild. The last killing frost in the spring usually occurs in the middle of April, and the first killing frost in autumn is normally the last of October. During the winter months, snowfall is only moderate and seldom covers the ground for more than a few days at a time. The average annual temperature is about 57° F.

21. During the most severe flood of record on the North Fork River a dam at the Norfork site for flood control would back water about 36 miles upstream along the main valley, and the maximum width of the pool would be approximately 1 mile. Such a large flood, which would be infrequent, would cover about 14,000 acres, and the land covered would lie largely in Baxter County, Ark.; however, a small section would be covered along tributaries in Fulton County, Ark., and the pool would extend along the channel of the main stem into Ozark County, Mo., for a distance of about 1 mile. Following a flood, the impounded floodwater would be released, lowering the water in the reservoir to the permanent conservation pool stage maintained for recreation and wildlife purposes. This permanent pool would be about 13 miles long and would have an area of about 1,700 acres.

22. A dam constructed for the combined purpose of flood control and the development of hydroelectric power would form a power pool having a length along the main valley of about 45 miles (about 10 miles in Missouri) and covering an area of 22,000 acres (19,900 acres in Baxter County, Ark.; 900 acres in Fulton County, Ark.; and 1,200 acres in Ozark County, Mo.). A space above the power pool would be reserved for flood control. During the maximum flood of record, the water retained for power purposes plus that temporarily retained above the power pool for flood-control purposes would extend along the main stem upstream from the dam for a distance of 47 miles (about 12 miles in Missouri) and the dual-purpose pool thus formed would cover a total of about 29,000 acres of land (25,000 acres in Baxter County, Ark.; 1,500 acres in Fulton County, Ark.; and 2,500 acres in Ozark County, Mo).

23. Generally, the land within the reservoir area is covered with woods, the cultivated area being mostly confined to the narrow flood plains. Only about 20 percent of the total area is cultivated. No known mineral deposits of commercial value lie within the proposed reservoir.

24. The soil in the vicinity of the proposed reservoir is a residuary product of weathering and is relatively thin on the hills. Most of the flat-topped ridges in the vicinity reach elevations of 775 feet to 825 feet; however, some of the higher nearby peaks reach elevations in excess of 1,175 feet above mean sea level. Most of the hills are capped with Calico Rock Sandstone of the Middle Ordovician age. The sandstone is underlain with the Powell, Cotter Dolomite, and Jefferson City Dolomite limestone formations, respectively. The relatively flat-lying limestone strata in the region have been gently folded, in some cases faulted, and eroded into deeply cut valleys with narrow uplands. The larger streams follow winding courses through deeply entrenched post-Eocene meanders, with bluffs on the outside and moderate slopes to the uplands on the inside of the bends. The

smaller streams usually follow fairly straight narrow valleys. The water level in the North Fork River at the dam site is normally 375 feet above mean sea level.

25. The portion of the Norfork Reservoir area in Arkansas is covered by the United States Geological Survey, Department of the Interior, quadrangle map, "Mountain Home, Ark.-Mo." This quadrangle map also covers practically the entire portion of the North Fork River drainage area in Arkansas. The survey was made in 1890, and the map is published on a scale of 1:125,000, contour interval 50 feet. Since this quadrangle was surveyed about 50 years ago, the map does not show existing improvements. Practically all of the portion of the Norfork Reservior area in Missouri is covered by the United States Geological Survey, Department of the Interior, quadrangle map, "Gainesville, Mo." The survey was made during the period 1932 to 1934, and the map is published on a scale of 1:62,500, contour interval 20 feet. This quadrangle map, together with the advance sheets of the "Buckhart, Mo." and "Ava, Mo." quadrangle maps, also prepared by the United States Geological Survey, covers the western portion of the North Fork River Basin in Missouri. These advance sheets are on a scale of 1:48,000, contour interval 20 feet. The surveys for the "Buckhart, Mo." quadrangle were made in 1933, 1936, and 1937. The surveys for the "Ava, Mo." quadrangle were made in 1935 and 1936. Mapping of the eastern part of the basin in Missouri has not yet been completed. A detailed map of the proposed Norfork Reservoir area was made in 1939 by the United States Engineer Department. This unpublished map is on a scale of 1:10,000, with a contour interval of 10 feet. The extent of the North Fork River Basin, Norfork Reservoir areas, and other pertinent data are shown on the attached map entitled "Norfork Dam, North Fork River, Ark. and Mo., Watershed Map," dated December 10, 1940. The reservoir areas shown on this map are those which would be reserved for flood control or flood control and power development and are somewhat larger than the areas which would be covered by the maximum flood of record as heretofore described.

26. *Economic development.*—The areas and populations of the three counties in which the Norfork Reservoir site is located, the populations of the larger towns in these counties, and other pertinent information are given in table No. 4.

TABLE NO. 4.—*Area and population of counties*

Counties and towns	Land area in county in 1930 (square miles)	Population				Percent of increase, 1920–30
		1910	1920	1930		
				Total	Per square mile	
Ozark County, Mo	746	11,926	11,125	9,537	12.8	−14.3
Gainesville (county seat)		195	256	235		−8.2
Bakersfield				181		
Baxter County, Ark	586	10,389	10,216	9,519	16.2	−6.8
Cotter		894	884	1,064		20.4
Mountain Home (county seat)		446	492	585		18.9
Norfork			224	247		10.3
Gassville		198	191	227		18.8
Fulton County, Ark	625	12,193	11,182	10,834	17.3	−3.1
Mammoth Spring		817	700	600		−14.3
Salem (county seat)				481		
Total for the 3 counties	1,957	34,508	32,523	29,890	15.3	−8.1

Published data are not yet available to indicate the trend of population since 1930, but information obtained for 1940 by the local census bureau indicates no appreciable change.

27. Table No. 5 gives pertinent information on occupations and industries.

TABLE NO. 5.—*Occupations and industries*

[Information is for the year 1930]

Item	Ozark County, Mo.	Baxter County, Ark.	Fulton County, Ark.	Total for the 3 counties
Number of persons engaged in gainful occupations	2,958	3,019	3,252	9,229
Number of persons engaged in agriculture	2,430	1,935	2,517	6,882
Number of persons engaged in forestry and fishing	2	16	14	32
Number of persons engaged in mining	2	9	1	12
Number of persons engaged in manufacturing	74			74
Number of farms	1,804	1,447	1,853	5,104
Land in farms, square miles	421	278	396	1,095
Value of crops, dollars	735,219	639,366	1,034,028	2,408,613
Value of dairy products, dollars	225,279	138,670	135,764	499,713
Value of livestock, dollars	1,219,992	675,348	927,210	2,822,550
Value of manufactured products, dollars	139,285			139,285

28. Agriculture is the most important occupation in the vicinity of the reservoir site; however, there are extensive unproductive areas which are largely covered with woods having little commercial value. The principal crops are corn, alfalfa and other hay, small grain, and cotton. Cattle raising and dairying are of considerable importance.

29. The Ozark region of southern Missouri and northern Arkansas is said to be rich in metallic minerals. The tri-State zinc-lead district, lying largely in southwest Missouri in the vicinity of Joplin (about 130 miles northwest of the Norfork Dam site), has for many years been an important source of zinc and lead in the United States, but the higher-grade ores in the district are being rapidly depleted. Zinc and lead ore production in northern Arkansas is almost entirely marginal owing to the relatively small size of the known individual deposits; however, during the war years, when exceptionally high prices existed, a considerable amount of ore was taken from these known deposits. Reserves of economically recoverable zinc in northern Arkansas have not yet been fully estimated, but it is the general opinion that they are rather large. The economically recoverable zinc from 13 small mines in the Rush Creek (tributary of the Buffalo River) area has been estimated at 70,295 short tons and the State geologist has stated that a survey of the zinc reserves may demonstrate that there are 200,000 tons of economically recoverable metallic zinc in northern Arkansas. It has been estimated that the known zinc reserves of the United States will largely be exhausted within the next few years and this may result in future utilization of districts in the Ozark region not now being developed.

30. Iron ore is found in several fields in southern Missouri, but production from these deposits has never been of national importance. The recent discovery of manganese carbonate deposits in the Batesville district in north Arkansas may have an important bearing on future manganese mining activity as the quantity of reserves has been substantially increased by this discovery. Prior to the discovery of the Batesville field, ore in northern Arkansas containing 40 percent or more of manganese had been estimated at 250,000 long tons and

containing less than 40 percent of manganese at 170,000 tons; however, none of the fields have yet been extensively mined.

31. Other metallic minerals in the Ozark region of southern Missouri and northern Arkansas include small quantities of copper, silver, and pyrites. Nonmetallic minerals in the region include sand and gravel, limestone, phosphate rock, sandstone, marble, glass sand, clay, and tripoli. The reserves of most of these nonmetallic minerals are said to be practically unlimited.

32. Although not in the Ozark region, it is of importance to point out that the bauxite mines in the vicinity of Little Rock, Ark., 100 miles south of the Norfork Dam site, have produced more than 90 percent of the bauxite produced in the United States since 1923. Bauxite is at present the only commercial source of metallic aluminum. It has been estimated that at least 20,000,000 tons of economically recoverable ore are available in the vicinity. The ore from the bauxite mines in Arkansas is at present shipped to eastern States where it is reduced to metallic aluminum.

33. The White River branch line of the Missouri Pacific Railroad Co. crosses the North Fork River at mile 0.2, or 4.6 miles downstream from the Norfork Dam site. Arkansas State Highway No. 5, a gravel-surfaced road, parallels and is just upstream from the Missouri Pacific Railroad crossing. Missouri State Highway No. 80 (mile 48.4) and United States Highway No. 62 (mile 20.0) cross the North Fork River within the limits of the Norfork Reservoir site. Arkansas State Highway No. 101 crosses Bennetts River (mile 20.4) within the limits of the site. All of these highways are gravel surfaced and have concrete or steel bridges at the stream crossings. In addition to the highways, there are a few county roads within the reservoir limits. These county routes are either improved or unimproved dirt roads and normally cross the streams by means of fords.

34. *Precipitation and stream flow.*—The average annual precipitation over the North Fork River Basin above the Norfork Dam site, based on the standard United States Weather Bureau 35-year mean at stations near the basin, is 44.96 inches; however, there are wide departures from this average. The maximum annual precipitation of record, subsequent to 1900, was 72.0 inches in 1927 and the minimum was 24.66 inches in 1901. The average monthly and annual precipitations are given in table No. 6.

TABLE NO. 6.—*Average monthly and annual precipitations, North Fork River Basin above Norfork Dam site*

[Standard U. S. Weather Bureau 35-year mean]

Month	Average precipitation	Percent of average annual precipitation	Month	Average precipitation	Percent of average annual precipitation
	Inches			*Inches*	
January	3.12	6.9	August	4.29	9.6
February	2.50	5.6	September	4.07	9.0
March	3.75	8.3	October	3.55	7.9
April	4.61	10.2	November	2.96	6.6
May	4.71	10.5	December	2.91	6.5
June	4.68	10.4			
July	3.81	8.5	Annual	44.96	100.0

35. There are a few precipitation stations in the North Fork River drainage area, some of which are not now in use, but the periods of records of all of them are relatively short. Therefore, stations outside but near the basin were used for the studies made for this report. The periods of records of all precipitation stations in and near the basin are shown on chart 1,[1] and the location of each station is shown on the "Watershed Map" attached hereto.

36. The region in which the North Fork River Basin lies is subject to intense local storms, as well as general storms of heavy rainfall extending over several days. The more notable storms of record are of the latter type and have been responsible for the major floods. Storms of large magnitude occur most frequently during the spring and summer months; however, records show that they may occur at any time of the year. Storms producing the major floods of record on the North Fork River occurred in August 1915, January 1916, and April 1927. Other storms which produced considerable flooding occurred in July 1905, June 1928, March 1935, February 1938, and April 1939. Consequently, in the operation of a dual-purpose flood-control and power reservoir on the North Fork River, storage space above the power pool has been reserved exclusively for flood control to provide dependable control of flood flows at all seasons of the year.

37. The periods of records and other data for stream gaging stations on the North Fork River are given in table No. 7. The location of each gage is indicated on the "Watershed Map" attached hereto.

[1] Not printed.

TABLE NO. 7.—*Stream-gaging stations on the North Fork River*

[Compiled in October 1940]

Station	Miles above mouth	Drainage area (square miles)	Flood stage (feet)	Maximum stage of record (feet)	Minimum stage of record (feet)	River stages by—	Discharge measurements by—	Period of record
Tecumseh, Mo	48.4	1,150	24.0	[1] 24.0	0.74	U. S. Geological Survey	U. S. Geological Survey	Oct. 24, 1921, to date.
Henderson, Ark	20.0	1,590	23.0	[2] 22.2	1.05	do	do	July 1, 1909, to Dec. 31, 1910; Oct. 1, 1928, to date.
Friends Ferry, Ark.[3]	5.6	1,763	([4])	14.0	1.51	Dixie Power Co	Dixie Power Co	Nov. 4, 1922, to Dec. 15, 1925.
Norfork Dam site [3]	4.8	1,765	([4])	[5] 2.8	1.84	U. S. Engineer Department	None	May 8, 1940, to date.
Norfork Dam site No. 3 [3] (near)	4.2	1,766	22.0	[6] 19.0	−.20	do	U. S. Engineer Department	June 8, 1938, to date.
Norfork, Ark.[3]	.2	1,780	([4])	[7] 21.9	3.99	do	None	Mar. 28, 1940, to date.

[1] Flood of July 1905, the highest known at the locality, reached a stage equivalent to 31.6 feet on the gage.
[2] Flood of August 1915, the highest known at the locality, reached a stage equivalent to 29.5 feet on the gage.
[3] Station affected by backwater from the White River.
[4] Flood stage not established.
[5] Flood of January 1916, the highest known at the locality, reached a stage equivalent to 37 feet on the gage.
[6] Flood of January 1916, the highest known at the locality, reached a stage equivalent to 36 feet on the gage.
[7] Flood of January 1916, the highest known at the locality, reached a stage equivalent to 54 feet on the gage.

38. Flows have been estimated at the Norfork Dam site for the period October 24, 1921, to September 30, 1939. These flows were based upon stream flow records for the Tecumseh and Henderson gages. The estimated average, maximum, and minimum annual run-offs and the maximum and minimum monthly run-offs, at the dam site, are given in table No. 8.

TABLE No. 8.—*Estimated annual and monthly flows at the Norfork Dam site*

Item	Period	Acre-feet	Inches	Average rate (cubic feet per second)
Average annual	18 years	1,356,000	14.4	1,860
Maximum annual	1927	3,366,000	35.8	4,610
Minimum annual	1936	541,700	5.8	740
Maximum monthly	April 1927	914,000	9.7	15,200
Minimum monthly	August 1936	19,880	.2	321

39. For the purpose of estimating the amount of hydroelectric power available, average weekly flows were computed at the Norfork site by using actual stream flow records for the Tecumseh and Henderson gages. The period 1923 to 1938, inclusive, was chosen for the computations because this period is representative of the entire period of flow records and contains the critical period for computing the prime power. In order to determine whether the flows for the period of flow records are representative of flow conditions over a much longer period of time, a comparative study was made of the precipitation records since 1895 for stations adjacent to the North Fork River Basin. This comparative study indicates that a more critical low flow condition might have existed from the latter part of 1898 through the early part of 1902; therefore, in computing the prime power, a reduction was made for possible future lower flows than are indicated by the period of flow records chosen for the computations. A duration curve of the estimated natural flow at the dam site, based upon the period 1923 to 1938, inclusive, is shown on chart 2.[1] This chart also shows a duration curve for the estimated regulated flow which would result from the 707,000 acre-feet of power draw-down storage as set forth later in this report.

40. *Improvement desired.*—A public hearing was held by the district engineer, at Harrison, Ark., on September 6, 1940. The attendance, which was large (about 700 persons), included Federal, State, county, city, and town officials; farmers; landowners; and businessmen. United States Senator John E. Miller and Representative Clyde T. Ellis were present. Federal agencies represented included the Rural Electrification Administration, Soil Conservation Service, Forest Service, National Park Service, Geological Survey, Farm Security Administration, and the Fish and Wildlife Service. Agencies of the State of Arkansas which were represented included the Department of Public Utilities, Flood Control Commission, Agricultural and Industrial Commission, Game and Fish Commission, Forestry Commission, Planning Board, Health Department, Park Commission, and Agricultural Extension Service. Although the Arkansas State Geologist was not present, he submitted a written statement for the record.

[1] Not printed.

The Missouri Conservation Commission was represented. Other concerns represented included the Arkansas Power & Light, Empire District Electric, Oklahoma Gas and Electric, Union Electric of Missouri, and Southwestern Gas and Electric Co.'s; the Missouri Pacific Railroad, and Missouri and Arkansas, St. Louis-San Francisco, and Atchison, Topeka & Santa Fe Railway Co.'s; local rural electric cooperative corporations; Arkansas Wildlife Federation; Ozark Mine Owners League; White River Boosters League; civic clubs; chambers of commerce; and newspapers. A report of the public hearing is attached and marked Appendix No. 1.[1]

41. Local interests are unanimous in their desire that the Norfork Dam be constructed for the combined purpose of flood control and the development of hydroelectric power and they desire that provisions for power generation be made at this time. Interests of Missouri and Arkansas who are situated in the vicinity of the upper White River Basin are primarily interested in hydroelectric, recreation, and wildlife development, while those situated in the downstream portions of the valley are primarily interested in flood control. The advocates in each case, recognizing the needs and desires of the others, are of the opinion that the project should be for the combined purpose of flood control and hydroelectric power. Not a single protest against provisions for power generation in the Norfork Dam has been received; however, certain interests desire that wildlife and recreation be taken into consideration in the design and operation of the structure.

42. Generally, the urgent need for additional power capacity; the demand for cheap electric energy for industrial, commercial, and domestic purposes; and the desire for recreational facilities were the principal reasons advanced by the sponsors for the justification of power provisions. The local interests pointed out that cheap power would insure the development of their mineral and other natural resources, provide favorable conditions to attract new manufacturing plants for finishing their raw products, minimize the relief problem, stabilize population, and stimulate business in all of its branches. They believe that additional power, together with the favorable effect it would have upon developing and processing the natural resources in the strategically located region, would be a great asset in the present national-defense program. It was stated that there was a shortage of power during the World War years, 1917 and 1918, and that the country was thus greatly inconvenienced. Interested parties also pointed out that a dual-purpose flood-control and power reservoir would be of very great value from a recreational and wildlife conservation standpoint owing to the large permanent body of water; whereas, a flood-control reservoir would not be nearly so valuable for this purpose.

43. The most frequently mentioned minerals found in commercial quantities in the Ozark region of southern Missouri and northern Arkansas included zinc and lead, iron, manganese, limestone, phosphate rock, sandstone, marble, glass sand, clay, dolomite, and tripoli. The local interests repeatedly called attention to the fact that the bauxite (aluminum ore) mines in the vicinity of Little Rock produce more than 90 percent of the bauxite produced in the United States. They also mentioned cinnabar, an ore of mercury, which is found in southwest Arkansas. Some of the minerals were said to be classed as strategic minerals in the event of war. It was stated that with an

[1] Not printed.

abundance of cheap power the minerals in the region could be more extensively mined and could be processed locally instead of being transported to far-distant processing plants.

44. Statistical data were submitted which indicated that a very large percentage of the energy utilized in Arkansas is produced in neighboring States, and that these power sources, in the not-far-distant future, may be unable to furnish power to Arkansas owing to increase in local demand in those States. It was claimed that there is now a need for the energy that would be produced at the Norfork Dam. Arkansas interests are fearful that because of the increased demand which will be brought about by the national-defense program, together with the possibility that a large amount of the energy now received from outside the State might not be available in the future, there might result a serious power shortage if additional capacity is not obtained in the very near future.

45. According to information presented by the Arkansas Department of Public Utilities, the net amount of energy received from outside the State boundaries in 1939 was about 62 percent of the amount of energy consumed in Arkansas. A comparison of installed capacity and generation in the five States of Arkansas, Oklahoma, Missouri, Louisiana, and Mississippi, as given by that State agency, is shown in table No. 9. These five States were selected for comparison because it was said that the power from the Norfork Dam would no doubt be utilized in those States.

TABLE NO. 9.—*Comparison of installed capacity and generation in the 5 States: Arkansas, Oklahoma, Missouri, Louisiana, and Mississippi*

Item	1927	1932	1939
Installed capacity, kilowatts	1,066,231	1,606,813	1,770,300
Percent increase in installed capacity		51	10
Generation, 1,000 kilowatt-hours	2,957,146	3,587,328	4,887,177
Percent increase in generation		21	36

46. The installed capacity in Arkansas for the year 1939 was given by the Arkansas Department of Public Utilities as 158,703 kilowatts. Although Oklahoma and Louisiana generated more energy than was required in those two States, the deficit in the other three States was so large that for the five-State area it was necessary to import a net of about 26 percent of the total energy used in that area in 1939, according to the Arkansas Department of Public Utilities. It was pointed out that while the generating capacity was increased only 10 percent during the 7-year period, 1932 to 1939, the demand for electric energy increased 36 percent in the five States. It was stated that the power companies have been able to take care of the increased load during the last few years through interconnections with other power companies or through more continuous operation of the installed facilities, and, through interconnections, advantages have been taken of the diversity of load between systems, as well as the surplus power or excess capacity that was available in the various systems. The Arkansas Department of Public Utilities is of the opinion that little additional spare capacity except for off-peak usage can be obtained through additional interconnections.

47. In reply to a recent letter from United States Congressman Clyde T. Ellis, in which the importance of power features in the Norfork Dam was discussed, the President of the United States said—

> It appears desirable that the necessary authority for the higher dam be secured at this time, not only because of the savings to the Federal Government which would be accomplished by such construction, but also on account of the desirability of providing for the future installation of power-generating machinery.

The President also stated—

> In times of national emergency such as these, the importance of an adequate supply of electric power for national defense purposes cannot be over-stressed.

48. *Surveys.*—This survey report is based to a large extent upon recent project studies for the proposed Norfork Dam and Reservoir. Field investigations made for those studies included topographic and hydrographic surveys, foundation explorations, land and improvement appraisals within the reservoir, and field inspections of the areas. A detailed reservoir map to a scale of 1:10,000, contour interval 10 feet, was prepared, by multiplex methods, from aerial photographs and field control surveys, and detailed plane table maps of four dam sites were also prepared. The hydrographic surveys included the location and elevation of high-water marks, stream profiles, waterway openings at bridges, and channel and valley cross sections. Extensive subsurface explorations were made in the lower reach of the North Fork River for the purpose of selecting the axis of the dam and for the design of the structure. Surface geology studies were made for the entire reservoir area. A power market study (appendix No. II) [1] was made specifically for this report by the Federal Power Commission.

49. The following maps and drawings, which are attached hereto, were compiled from the surveys made for the project studies and from other available information:

Title:	Data shown
Watershed Map	North Fork River watershed, White River Basin, Norfork Dam site, extent of proposed reservoir, and other pertinent information.
Stream Profiles of North Fork and White Rivers.[1]	Channel and high-water profiles, location of recommended Table Rock and Bull Shoals Dams, proposed Norfork Dam, and existing locks and dams Nos. 1, 2, and 3.
Cultivated Land Within Reservoir.[1]	Extent of cultivated areas in proposed dual-purpose flood-control and power reservoir.
Plan and Elevation of Dam [1]	Details of plan of improvement for dual-purpose flood-control and hydroelectric power dam, and upstream elevation of the structure.
Elevation and Sections of Dam [1]	Downstream elevation of dual-purpose dam, typical bulkhead section, section through spillway and flood-control conduits, and section through intake and powerhouse.

50. *Power market for the Norfork project.*—The Federal Power Commission recently made a power market study of the area which might be served by the proposed power development at the Norfork project. The purposes of the study were to estimate the power needs of the area and to determine the value of the power that could be produced by

[1] Not printed.

the project. A copy of the Commission's report on the power market study is attached and marked Appendix No. II.[1]

51. The area considered by the Commission as being available to the proposed initial installation at the Norfork project is that served by the interconnected main systems of the Arkansas Power & Light Co., Louisiana Power & Light Co., Mississippi Power & Light Co., Arkansas-Missouri Power Corporation, and Citizens Electric Co. These five electric-utility concerns serve most of Arkansas and Louisiana, and the western half of Mississippi. After making an allowance for obligated interchange of power capacity with other systems outside the area and deducting minimum reserve requirements, the Commission finds, based upon the present dependable capacity (196,330 kilowatts) of generating plants belonging to the five concerns, that the net assured capacity in 1942 for serving loads in the area is 194,000 kilowatts.

52. In 1939 the total energy requirements were 950,000,000 kilowatt-hours and the aggregate maximum demand in the area was approximately 200,000 kilowatts. The Federal Power Commission estimates that in 1950 the energy requirements will increase to not less than 1,670,000,000 kilowatt-hours and the maximum demand will be 335,000 kilowatts. Table No. 10 shows the Commission's estimates of the future energy requirements, maximum demands, and additional capacity requirements.

TABLE No. 10.—*Future power load and additional capacity requirements as estimated by the Federal Power Commission*

[Portions of Arkansas, Louisiana, and Mississippi served by the Arkansas, Louisiana, and Mississippi Power & Light Co.'s, Arkansas-Missouri Power Corporation, and Citizens Electric Co.—Assured capacity in 1942, 194,000 kilowatts]

Year	Energy requirement (millions of kilowatt-hours)	Maximum demand (kilowatts)	Additional dependable capacity requirement, exclusive of reserves (kilowatts)
1942	1,200	253,000	59,000
1943	1,270	267,000	73,000
1944	1,340	279,000	85,000
1945	1,410	291,000	97,000
1946	1,470	302,000	108,000
1947	1,530	312,000	118,000
1948	1,580	320,000	126,000
1949	1,630	328,000	134,000
1950	1,670	335,000	141,000

53. *Plans considered.*—Existing authority provides for the construction of a flood-control reservoir at the Norfork site and further provides that penstocks or other similar facilities adapted to possible future use in the development of hydroelectric power shall be installed in the dam when approved by the Secretary of War upon the recommendation of the Chief of Engineers and of the Federal Power Commission. The installation of penstocks has been recommended and approved.

54. Four plans have been considered with a view to reaching a conclusion as to the best development of the Norfork Dam site. The plans considered were (1) a flood-control dam with penstocks installed for future power generation; (2) a flood-control dam with penstocks

[1] Not printed.

and widened base which would permit enlarging and raising the height of the dam at a subsequent date for power generation in conjunction with flood control; (3) a dam, with penstocks, constructed to the full height required for the dual purpose of flood control and power generation, but the power-generating equipment to be installed at some subsequent date; and (4) a dam constructed to the full height required for the combined purpose of flood control and power generation with power-generating equipment installed at this time.

55. In the first plan, in which the flood-control dam might at some future time be converted to power use, full advantage of the water resources of the North Fork River Basin would not be realized, nor would the best economic development of the site be provided. The dam and reservoir included in the first plan would cost only slightly more than the estimated cost of $14,000,000 for a flood-control only structure without any provisions for future power generation. It would not be practicable under the first plan to convert the structure to the dual-purpose use of flood control and power generation.

56. Greater rates of return on the investment could be obtained from a dual-purpose project. Plans 2 and 3 provide for the ultimate development of the site for the combined purpose of flood control and power generation. The estimated costs of the reservoirs included in the second and third plans are $16,000,000 and $20,000,000, respectively. The additional investment over plan 1, which would amount to $2,000,000 for plan 2 and $6,000,000 for plan 3, would remain idle until actual conversion of the structure to the dual purpose. Although the third plan would require a greater initial investment, it is more desirable than the second plan because in the latter case the conversion to a dual-purpose dam would require two-stage construction which would increase the ultimate total cost of the project by more than a million and a half dollars. Therefore, the third plan is the best of the first three considered since it would not destroy the site for the dual purpose and would permit the most practicable and least costly ultimate development.

57. *Plan of improvement.*—Since the Federal Power Commission has found that there will be a market for the power that could be generated at the Norfork project by the time it could be completed, and since the generation of hydroelectric power in conjunction with flood control would be economically justified as will later be shown in this report, it is most advantageous to the United States to select the fourth plan, which is described in more detail in subsequent paragraphs.

58. Hydrological studies indicate that a major flood may occur when the power storage is filled; therefore, the flood storage proposed in the top part of the dual-purpose reservoir is the same as that required for a flood-control-only reservoir. With the amount of flood storage thus fixed, studies were made of several dam heights in order to determine the amount of storage which should be provided for power purposes. These studies indicate that the power storage, including both dead and draw-down storage, set forth in the following paragraph would result in the greatest rate of return on the power investment. Although it is possible to increase the height of the proposed dual-purpose dam and thus obtain greater power storage, the increased cost of the structure and the increased damages that would result from a substantially increased height would not be justified by the increased power benefits.

59. The dual-purpose dam at the Norfork site has been designed to form a reservoir of 1,983,000 acre-feet capacity of which 732,000 acre-feet have been reserved for flood control and the balance, 1,251,000 acre-feet, has been reserved for power. Studies indicate that of the 1,251,000 acre-feet reserved for power, 707,000 acre-feet, equivalent to a linear draw-down of 42 feet, should be used for the purpose of stream-flow regulation. Although studies indicate this draw-down to be the most advantageous operation of the power pool at this time, the penstock intakes are at an elevation which is low enough to allow the draw-down to be materially increased if such becomes desirable. As recommended by the Federal Power Commission, the plan provides for two power-generating units with a capacity of 30,000 kilowatts each, attached to penstocks which are 18 feet in diameter. Two additional 18-foot penstocks are included in the plan so that additional generating units can be installed if such are ever desired. The plan also provides for power transmission facilities to existing load distribution centers. The dam would be of concrete gravity construction with controlled spillway and sluices. Extensive subsurface explorations indicate the foundation to be suitable for the construction of the high-head dam proposed. Duration curves of head and power for the proposed dual-purpose development are shown on chart 3.[1]

60. Bridges within the Norfork Reservoir limits and the alterations required are listed in table No. 11. Since the North Fork River is not considered navigable, none of the bridges were constructed under a War Department permit.

TABLE No. 11.—*Existing bridges within Norfork Reservoir limits and alterations required*

Transportation route	Stream crossing	Miles above mouth of North Fork River	Description of bridge	Elevation of bridge deck (feet, mean sea level)	Bridge alteration required	
					Flood-control reservoir	Flood-control and power reservoir
Missouri State Highway No. 80.	North Fork River.	48.4	3-span, steel, through truss.	585	None	None.
Arkansas State Highway No. 101.	Bennetts River	20.4	160-foot steel girder with reinforced concrete deck.	509	do	To be abanboned.
	Walkers Branch (tributary of Bennetts River).	20.4	80-foot steel girder with reinforced concrete deck.	495	do	Do.
United States Highway No. 62.	North Fork River.	20.0	888-foot multiple arch concrete.	487	To be abandoned and new bridge to be constructed on a relocated highway route.	To be abandoned and new bridge to be constructed on a relocated highway route.
Hand Road (county).	Float Creek	17.2	Single-span reinforced concrete.	441	None	To be abandoned.

61. Pertinent information for the transportation routes within the limits of the reservoir and the alterations required are given in table No. 12.

[1] Not printed.

TABLE NO. 12.—*Transportation routes within Norfork Reservoir limits and alterations required*

Highway or road	Type of road	Stream crossing	Miles above mouth of North Fork River	Effect of reservoir on present road		Alteration required	
				Flood-control reservoir	Flood-control and power reservoir	Flood-control reservoir	Flood-control and power reservoir
Missouri State Highway No. 80.	Gravel	North Fork River	48.4	None	None	None	None.
Pigeon Creek Road (county).	Improved dirt	Pigeon Creek	27.8	do	Flooded permanently	do	Raise approaches and construct a bridge.
Red Bank Road (county).	Unimproved	do	27.8	Frequency of flooding will not be increased.	do	do	Stream crossing to be abandoned. An existing road north of crossing to be extended to provide an outlet to Pigeon Creek Road.
Arkansas State Highway No. 101.	Gravel	Bennetts River	20.4	Flooded only during major floods.	do	do	To be relocated.
United States Highway No. 62.	do	North Fork River	20.0	Flooded during major floods.	do	To be relocated	Do.
Hand Road (county)	Improved dirt	Float Creek	17.2	Flooded frequently	do	Construct a bridge at the Big Creek crossing and improve the unimproved portions of 2 existing roads leading to U. S. Highway No. 62, one of which is north of Big Creek and the other north of Float Creek.	Both crossings to be abandoned. Improve the unimproved portions of 2 existing roads leading to U. S. Highway No. 62 as proposed for the flood-control reservoir.
		Big Creek	5.9	Flooded permanently	do		
Buzzards Roost Road (county).	Unimproved	Fall Creek (tributary of Panther Fork).	14.8	Frequency of flooding will not be increased.	do	None	None.

62. The Mountain Home Telephone Co. owns and operates the only communication line in the area to be occupied by the proposed reservoir. This line follows United States Highway No. 62 and Arkansas State Highway No. 101, connecting Mountain Home with Gamaliel, Ark. The line is considered a trunk line and serves about 50 customers. For a flood-control reservoir, it would be necessary to reroute the line along the rerouted portion of United States Highway No. 62 and to raise portions of the line along the existing Arkansas State Highway No. 101. In developing the site for the combined purpose of flood control and power, it would be necessary to follow the proposed relocated routes of both United States Highway No. 62 and Arkansas State Highway No. 101. There are no other utility lines affected by the proposed reservoir.

63. There are 15 rural cemeteries, containing approximately 1,110 graves, lying within the flood-control reservoir area, which would have to be relocated. In event the Norfork Dam should be constructed for the dual purpose of flood control and power development, three additional cemeteries containing approximately 200 graves would have to be relocated.

64. Table No. 13 gives information on areas and the estimated number of families in the proposed Norfork Reservoir Basin. The extent of the dual-purpose reservoir and the location of the cultivated areas are shown on the attached map, "Cultivated Land Within Reservoir.[1]" More than 4,000 acres of land in the reservoir area are under Federal ownership as unpatented lands.

TABLE No. 13.—*Areas and number of families in proposed Norfork Reservoir Basin*

Item	Flood-control reservoir	Flood-control and power reservoir
Total area, acres	15,600	30,700
Top of power pool, acres		22,000
Bottom of power draw-down, acres		12,300
Conservation pool (recreation and wildlife), acres	1,700	
Total area cultivated, acres	6,000	6,500
Cultivated area in power pool, acres		6,400
Total number of families	165	300

65. The rock dam across the North Fork River at mile 51.2, which is near the upstream limit of the proposed dual-purpose Norfork Reservoir and which is described heretofore in this report, has a top elevation of 572 feet above mean sea level. The tail water below the rock dam is at an elevation considerably above the proposed power pool elevation in the Norfork Reservoir and it is not anticipated that flooding of the structure would be any more frequent owing to the flood storage in the dual-purpose project than under present conditions.

66. The estimated cost of highway, road, cemetery, and utility property alterations and relocations, including engineering, overhead, and contingencies, is $900,000 for a flood-control reservoir. The estimated cost of those items for the proposed dual-purpose development of the site is $1,800,000.

67. The pertinent features of the proposed dual-purpose flood-control and power project are shown on the attached drawings, "Plan

[1] Not printed.

and Elevation of Dam" and "Elevation and Sections of Dam." [1] The engineering features are shown in table No. 14.

TABLE NO. 14.—*Engineering features for dual-purpose flood-control and power project at the Norfork site*

Location of dam, miles above mouth of North Fork River	4. 8
Drainage area, square miles	1, 765
Type of dam	Concrete gravity
Crest length of dam, feet	2, 640
Maximum height of dam, feet	231
Spillway design flood, cubic feet per second	338, 000
Spillway capacity, cubic feet per second	293, 000
Maximum peak discharge known, cubic feet per second	120, 000
Length of spillway, feet	600
Type of spillway	Controlled
Number of spillway gates	12
Maximum sluice capacity, cubic feet per second	40, 400
Type of sluiceways	Controlled
Number of conduits	12
Channel capacity below dam, cubic feet per second	60, 000
Top of dam, elevation in feet, mean sea level	588
Top of spillway gates, elevation in feet, mean sea level	580
Spillway crest, elevation in feet, mean sea level	555
Top of flood-control pool, elevation in feet, mean sea level	580
Top of power pool, elevation in feet, mean sea level	552
Area in reservoir (top of spillway gates), acres	30, 700
Area of power pool, acres	22, 000
Gross storage, acre-feet	1, 983, 000
Flood-control storage, acre-feet	732, 000
Power storage, acre-feet	1, 251, 000
Power draw-down storage, acre-feet	707, 000
Power draw-down, feet	42
Average regulated flow (critical period), cubic feet per second	1, 260
Net effective head (power pool full), feet	173
Net effective head (full power draw-down), feet	131
Average net effective head, feet	163
Number of penstocks	4
Diameter of penstocks, feet	18
Number of installed generators (initial)	2
Total installed generator capacity, kilowatts	60, 000
Maximum prime capacity available, kilowatts	58, 000
Average total energy output per year, kilowatt-hours	148, 000, 000
Prime energy output per year, kilowatt-hours	108, 000, 000

68. *Estimates of first cost of dual-purpose reservoir.*—The estimated first cost of a dual-purpose reservoir at the Norfork site, including engineering, overhead, and contingencies, is shown in table No. 15. More detailed estimates are shown in Appendix No. III.[1] The estimates are based upon carrying the project to completion in single-stage construction.

TABLE NO. 15.—*Estimated cost of dual-purpose flood-control and power project at the Norfork site*

Construction quarters and power line, additional foundation explorations, care of stream flow during construction, and reservoir clearing	$1, 460, 000
Concrete dam and spillway	16, 900, 000
Hydroelectric power plant, including switchyard structures and equipment	4, 300, 000
Alteration and relocation of highways, roads, cemeteries, and utility lines	1, 800, 000

[1] Not printed.

TABLE No. 15.—*Estimated cost of dual-purpose flood-control and power project at the Norfork site*—Continued

Operators' quarters, general clean-up, and landscaping	$240, 000
Lands, including acquisition costs	1, 300, 000
Power transmission facilities to existing load distribution centers	1, 500, 000
Total estimated cost of the dual-purpose project (estimated appropriation of public funds necessary for the execution of the project)	27, 500, 000

69. *Allocation of costs and annual charges for power development.*—Since the Norfork Dam has already been authorized as a flood-control structure, the economics of generating power should be based on the increased cost of developing the site for the dual purpose of flood control and power generation. The first cost of a flood-control reservoir, without any provisions for future power generation, has been estimated at $14,000,000. The estimated first cost of the dual-purpose project is $27,500,000. Therefore, the cost chargeable to power is $13,500,000. The estimated annual charges for the portion of the dual-purpose project chargeable to hydroelectric power are shown in table No. 16.

TABLE No. 16.—*Estimated annual charges for power development at a dual-purpose flood-control and power dam at the Norfork site*

Federal investment for power:	
Increased first cost of dual-purpose project over the first cost of a flood-control-only structure	$13, 500, 000
Interest during construction	810, 000
Total Federal investment for power	14, 310, 000
Annual charges for power development:	
3½ percent of Federal investment for power	501, 000
Amortization of Federal investment for power	141, 000
Operation and maintenance (increased annual cost for the dual-purpose project over that estimated for a flood-control-only structure)	70, 000
Total annual charges for power development	712, 000

The total estimated annual cost of operation and maintenance for the dual-purpose project is $90,000.

70. *Estimate of average annual power value.*—The estimated average total electrical energy at the dam available for transmission amounts to 148,000,000 kilowatt-hours per year. Of this amount, 108,000,000 kilowatt-hours are prime (dependable) energy. The remaining 40,000,000 kilowatt-hours are classed as "dump" energy which would be available intermittently, mostly during short flood periods, and there would be periods of a few consecutive years when no "dump" energy would be available. The proposed initial installation of 60,000 kilowatts would permit the transmission of 58,000 kilowatts of prime capacity for serving peak loads.

71. The report of the Federal Power Commission (Appendix No. II)[1] gives unit capacity and energy values. The unit capacity value is based upon the annual cost of supplying equivalent dependable capacity for serving loads by private concerns, exclusive of the cost of those elements of production which vary with the amount of energy generated, by alternative new fuel-burning plants. The unit capacity value

[1] Not printed.

thus given is $15.40 per kilowatt. The energy value given is 1.11 mills per kilowatt-hour and is based upon the cost of those elements of production by fuel-burning plants, largely fuel, which vary with the amount of energy generated. Transmission losses for the Norfork power would be greater than for power generated at alternate fuel-burning plants because the latter could be located at or near load centers. The study by the Commission indicates that these losses would average 5,000 kilowatts of capacity and 10,000,000 kilowatt-hours per year of energy more than corresponding losses for equivalent power generated in fuel-burning plants. Thus, the prime capacity for serving peak loads and the average annual energy which would be available at or near load centers from the proposed Norfork project amount to 53,000 kilowatts and 138,000,000 kilowatt-hours, respectively. Applying the unit capacity and energy values to these amounts, the gross average annual power value for the proposed project is $969,000.

72. The Federal Power Commission made studies of the relative system production costs with and without the proposed initial Norfork installation. These studies showed that certain economies would result from the operation of an alternate fuel-burning plant, and that the gross average annual value of the Norfork power, as measured by equivalent fuel-burning plant cost, would have to be reduced. After considering the results of the studies and the several factors which would affect the production costs of the area, it was concluded by the Commission that a fair average of the annual reduction which should be charged against the initial installation at the Norfork Dam would be about $75,000. Therefore, the estimated net average annual value of the Norfork power at or near load centers amounts to $894,000.

73. *Justification of power facilities in the Norfork Dam.*—A comparison of the estimated annual power charges with the estimated net average annual power value is indicated in the following tabulation:

Estimated annual charges for power development	$712,000
Estimated net average annual power value	$894,000
Ratio of annual power charges to net average annual power value	1 to 1.26

It is apparent that power facilities in the Norfork Dam are economically justified for serving peak loads when based upon the initial installation of 60,000 kilowatts recommended by the Federal Power Commission and upon the unit power values determined by that agency.

74. *Discussion.*—According to the Federal Power Commission's report (appendix No. II),[1] the power generated by the proposed initial installation at the Norfork project could be absorbed in the interconnected main systems of five electric utility concerns now serving most of Arkansas and Louisiana, and the western half of Mississippi. The present dependable capacity of plants belonging to these concerns amounts to 196,330 kilowatts. After making an allowance for obligated interchange of power capacity with other systems outside the area and deducting minimum reserve requirements, the Commission finds that the net assured capacity in 1942 for serving loads in the area is 194,000 kilowatts. The Commission states that there is now a shortage of assured capacity and that by 1944, the approximate date on which the Norfork project could be completed, not less than

[1] Not printed.

85,000 kilowatts of new capacity must be provided to adequately meet loads which will occur in that year, unless additional capacity is provided in the intervening years. The estimated additional capacity requirement for the area in 1950 is 141,000 kilowatts.

75. The Federal Power Commission concludes from its studies that the growth in area peak load could absorb the 58,000 kilowatts of prime capacity immediately upon the completion of the Norfork project, and that with the storage regulation the prime energy (108,000,000 kilowatt-hours per year) could be so utilized as to permit the entire initial project capacity to be used in serving peak loads of the area. Although at the present no plans for the installation of additional generating capacity in the area have been announced by the electric utility concerns, the Commission states in its report that if additions of capacity, indicated as necessary to serve loads which will occur before the Norfork dual-purpose project could be completed, were restricted so as not to provide any surplus at that time, half of the prime capacity of the project could be immediately absorbed and the remainder about 2 or 3 years later. Immediately upon completion of the project, the entire average annual available energy could be absorbed in replacing generation in the then existing fuel-burning plants.

76. The prime power from the proposed Norfork Dam could best be used in serving peak loads. Thus, the project should operate in extensive interconnected systems, such as exists in those which the project could serve, with fuel-burning plants serving the base load power; however, large hydroelectric plants of the type proposed herein normally operate in this manner. A single-circuit high-voltage transmission line from the existing transmission system at Newport, Ark., to the Norfork Dam site is now under construction by the Arkansas Power & Light Co. The estimated cost of the Norfork project as given hertofore includes an additional high-voltage transmission line to the existing transmission system at another locality, which would give a double circuit for dependable service.

77. In supplying power for the growing deficiency in the area, the power features of the project would be of benefit to industries. Studies made for this report indicate that the dual-purpose project operating to serve peak loads would generate power at somewhat less than the cost of generation by fuel-burning plants occupying equivalent load curve positions. There are additional advantages of the proposed hydroelectric development over other types of power development, but because of their nature they are classed as intangible benefits. These include the important factor of conservation of the natural resources, such as gas, oil, and coal. A large recreational area and wildlife refuge would result from the large permanent body of water reserved for power generation.

78. The Norfork Reservoir site is in the Ozark Mountains of southern Missouri and northern Arkansas. This area is noted for its clear streams and scenic beauty, and is perhaps the most outstanding recreational area between the Appalachian and Rocky Mountains. In mountainous areas, large bodies of water are ordinarily outstanding as centers of attraction. The only existing lake of importance in the immediate vicinity is Lake Taneycomo which is formed by a power dam at Ozark Beach on the White River. This lake is about 50 miles northwest of the Norfork Reservoir site. Lake Taneycomo has been

well developed for fishing and other recreational purposes, and it is visited by thousands of pleasure seekers annually. This lake is very small in comparison with the proposed power pool at the Norfork project, and it is no more favorably located from a recreational and wildlife standpoint. The recreation and wildlife benefits which would accrue from the power pool of the dual-purpose project would be large, but owing to their involved nature they cannot be definitely evaluated. Although there would be recreational and wildlife benefits from the authorized flood-control reservoir at the Norfork site owing to the small permanent body of water proposed in the bottom of the reservoir, such benefits would be small in comparison with those received from a dual-purpose flood-control and power reservoir because the permanent body of water would be many times greater than for the flood-control reservoir, and the fluctuations in water-surface elevations would be less extensive.

79. Other intangible benefits, actual and potential, would result from the power features of the project owing to the increased low-water flow below the dam. Navigation conditions would be improved in the White River and to a lesser degree in the Mississippi River downstream from the mouth of White River. In the event that more extensive works for a canalized White River should be constructed for navigation in the future, the regulated flow from the power pool would be of material value in providing a necessary water supply for lockage, leakage, and evaporation losses in the canalized system. Also, the regulation would increase potential power outputs at the existing locks and dams Nos. 1, 2, and 3, and would also increase the potential power at any other prospective dams on the main stem of the White River downstream from the North Fork River.

80. There is no demand or need of river water for irrigation in the White River watershed except for the cultivation of rice in the lower basin. This riceland is irrigated by pumping ground water, with the result that the water table is being lowered. There may be a future demand for river flows for rice irrigation, in which case the regulated flow resulting from the power features of the reservoir would be beneficial for this purpose. There is no shortage of municipal water supply, nor is there a serious stream pollution problem along White River.

81. Since the benefits from the power features of the proposed Norfork Dam would transcend State boundaries, interest in the development of the site for power purposes as well as for flood control is of national importance. According to the Federal Power Commission, the market for the power is in interconnected systems serving parts of three States—Arkansas, Mississippi, and Louisiana. In low-water periods, the regulated flow from the power storage would improve navigation conditions in the White River. This regulated flow would benefit Arkansas and, to a lesser degree, Mississippi and Louisiana on the navigable Mississippi River below the mouth of White River.

82. A dual-purpose flood-control and power dam at the Norfork site would result in a direct monetary return to the Federal Government owing to the sale of power; whereas, the presently authorized flood-control structure would result in no direct monetary return.

83. In a study of the merits of the recently recommended nearby Table Rock and Bull Shoals dual-purpose flood-control and power reservoirs on White River upstream from the North Fork River (H.

Doc. 917, 76th Cong., 3d sess.), the Federal Power Commission concluded that the power that could be produced at those projects could be absorbed by the expanding power markets of the region in a reasonable period of time. The Commission had previously had occasion to review the potential dual-purpose reservoir at the Norfork site and stated that the possibility of constructing a multiple-purpose project at that site in the same basin did not affect the conclusion with respect to the Table Rock and Bull Shoals projects. Furthermore, due to the diversity of flows in the North Fork and White Rivers and the fact that the proposed Norfork Reservoir would have relatively greater stream flow regulation, the Norfork project would, to a considerable extent, supplement the other two projects. Therefore, dual-purpose reservoirs at all three sites are essential to a comprehensive plan of developing the water resources of the White River Basin.

84. *Conclusions.*—The topography and foundation conditions in the North Fork River Valley are suitable for the construction of a dam for flood control or a higher dam for the dual purpose of flood control and hydroelectric-power generation. The volume and character of the flows in the North Fork River are such as to warrant the consideration of power generation in any plan of developing the stream. According to the report of the Federal Power Commission, there would be a market for the power which could be generated at the Norfork site as soon as the dam could be completed. A flood-control-only reservoir would not result in the best development of the site, would not utilize the water resources of the stream, and would not result in the greatest rate of return on the investment. Based upon the power values established by the Federal Power Commission and the district engineer's estimated costs of producing the power, the generation of power in conjunction with flood control at the Norfork Dam site is economically justified.

85. In addition to the direct monetary return to the Federal Treasury which would result from the sale of power, the power facilities of the proposed dual-purpose dam would result in other actual and potential benefits. The large permanent power pool would be of greater benefit from a recreational and wildlife standpoint than a small conservation pool in a flood-control reservoir. The regulated flow downstream from the dam occasioned by the power pool could be expected to improve navigation conditions and would increase power outputs at any potential downstream hydroelectric plants. The increased low-water flow downstream from the structure might prove beneficial in the future in many other ways, including the possibility of rice irrigation from White River in the lower part of the basin. The power facilities would be of great benefit to the general development of the area and would conserve natural resources, particularly gas, oil, and coal. Since a large part of the benefits would transcend State boundaries, the power facilities as well as the flood-control features in the proposed Norfork Dam are of national importance. The dual-purpose development of the Norfork site is essential to a comprehensive plan of developing the water resources of the White River Basin.

86. In order to assure the best power service to the area which would be served by the Norfork project, it is advisable that provisions be made to construct, operate, and maintain transmission lines, substations and facilities, and structures appurtenant thereto, as may be found necessary for the transmission, interchange, and sale of energy.

The estimated first costs and annual charges as given heretofore are based upon these facilities constituting a part of the project. Also, in order to safeguard the interests of navigation and flood control, the power facilities at the Norfork Dam should be constructed, operated, and maintained under the direction of the Secretary of War and the supervision of the Chief of Engineers. The power should be disposed of under contracts approved by the Federal Power Commission.

87. *Recommendation.*—I therefore recommend that the general comprehensive plan for flood control and other purposes in the White River Basin as approved in the Flood Control Act of June 28, 1938, be modified to approve the construction of the Norfork project on the North Fork River for the combined purpose of flood control and the development and distribution of hydroelectric power, in general accord with the plans presented herein, at an estimated cost to the United States of $27,500,000; that the existing authorization of $25,000,000 for the initiation and partial accomplishment of the basin reservoir plan be increased by $13,500,000 to provide for the immediate construction of the dual-purpose project at the Norfork site; and that the dam and power facilities be constructed, operated, and maintained under the direction of the Secretary of War and the supervision of the Chief of Engineers, the power to be disposed of under contracts approved by the Federal Power Commission. I further recommend that the estimated annual cost of operation and maintenance of the dual-purpose reservoir, amounting to $90,000, be approved.

S. L. Scott,
Lieutenant Colonel, Corps of Engineers,
District Engineer.

[First endorsement]

Office, Division Engineer,
Southwestern Division,
Little Rock, Ark., December 10, 1940.

To the Chief of Engineers, United States Army:

Forwarded, concurring in the recommendations of the district engineer.

S. L. Scott,
Lieutenant Colonel, Corps of Engineers,
Acting Division Engineer.

HOUSE DOC. NO. 290, 77TH CONG., 1ST SESSION

WAR DEPARTMENT

LEGEND

- Watershed divide
- 62 Federal highways
- 5 State highways
- 65 Stream miles above mouth
- Flood control reservoir
- Flood control and power reservoir
- U.S.G.S. gaging station
- U.S.E.D. gaging station
- Paved roads
- Gravel roads
- Improved dirt roads
- Unimproved roads and trails
- National forest boundary

RESERVOIRS APPROVED BY FLOOD CONTROL ACT OF 1938:

1- Clearwater
2- Water Valley
3- Bell Foley
4- Norfork
5- Lone Rock
6- Greers Ferry

RECOMMENDED RESERVOIRS:

7- Table Rock
8- Bull Shoals

VICINITY MAP

SCALE OF MILES 10 0 10 20 30 40

WHITE RIVER WATERSHED
NORFORK DAM
NORTH FORK RIVER, ARKANSAS AND MISSOURI
WATERSHED MAP
(SURVEY REPORT)

IN 1 SHEET — SCALE OF MILES 0 5 10 — SHEET NO. 1

U. S. ENGINEER OFFICE, LITTLE ROCK, ARKANSAS — DEC. 1940
SUBMITTED: — APPROVAL RECOMMENDED: — APPROVED:

F.O. Reeves — ENGINEER

MAJ., CORPS OF ENGINEERS, CHIEF, ENG. DIV.

LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: M.F.W. R.F.J.
TRACED: M.F.W.
CHECKED: F.O.R.

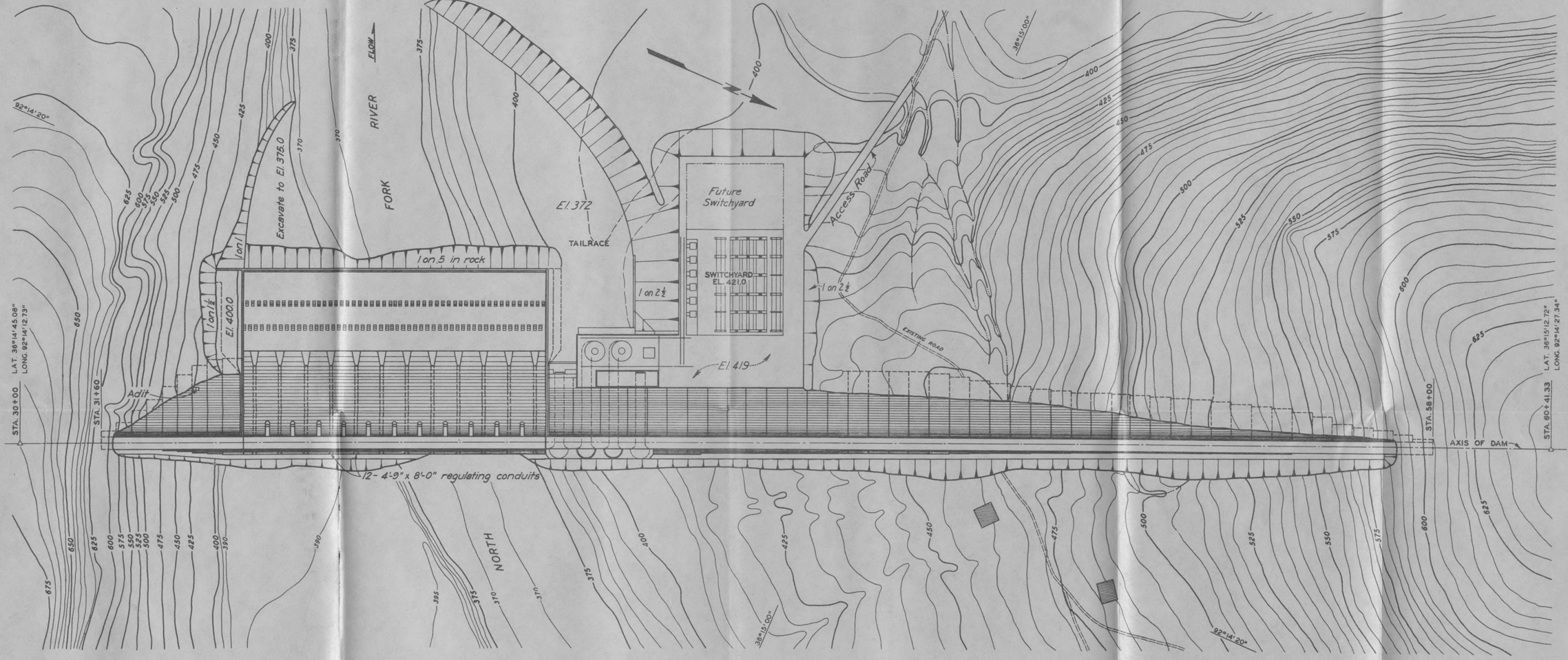
TO ACCOMPANY SURVEY REPORT DATED DECEMBER 10,1940

SERIAL 3107

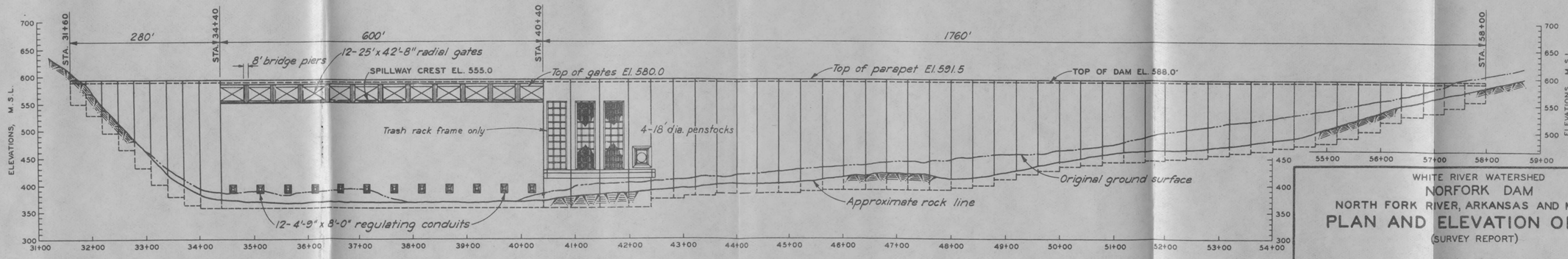
134/115

U. S. GOVERNMENT PRINTING OFFICE 1941 O-527823

CORPS OF ENGINEERS, U. S. ARMY



PLAN



UPSTREAM ELEVATION

WHITE RIVER WATERSHED

NORFORK DAM

NORTH FORK RIVER, ARKANSAS AND MISSOURI

PLAN AND ELEVATION OF DAM

(SURVEY REPORT)

SCALE OF FEET 100 0 100 200

U. S. ENGINEER OFFICE, LITTLE ROCK, ARK., DEC. 1940

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
ENGINEER	MAJ. CORPS OF ENGINEERS CHIEF ENG. DIV.	LT-COL CORPS OF ENGINEERS DISTRICT ENGINEER

DRAWN L.W.L. F.A.A.
TRACED P.M.K. F.L.
CHECKED F.A.A. F.H.W.

TO ACCOMPANY SURVEY REPORT DATED DECEMBER 10, 1940.

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HOUSE DOC. NO. 290, 77TH CONG., 1ST SESSION

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